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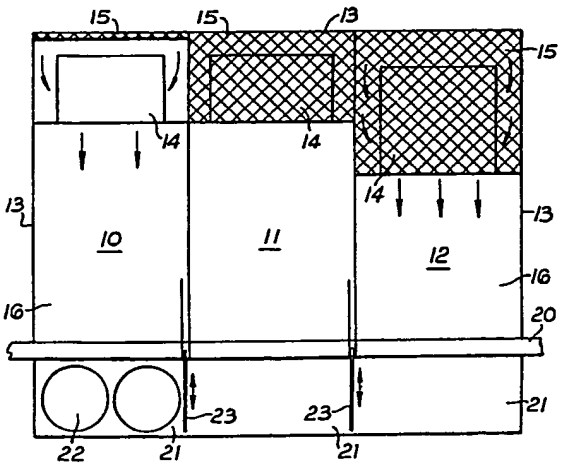
(54) Air conditioning system.

(57) An economical and efficient air conditioning system for supplying clean air to equipment, such as a main frame computer, comprises a row of units (10, 11, 12) arranged side by side. Each unit (1) has an impeller (14) which draws air in through a filter (15) and forces it through cooling means (16) to underfloor ducts which supply the equipment. Temperature sensors, e.g. under the floor, control the impeller speed and the cooling means temperature so that the equipment temperature is maintained in the narrow range required for optimum functioning. If one unit should fail or be shut down for servicing the adjacent units can provide temporary back-up by opening of dampers (23) at each side of the affected unit and increased impeller speed in the remaining units.



AIR CONDITIONING SYSTEM

This invention relates to an air conditioning system, particularly but not exclusively for environmental control of a computer room.

All current air conditioning systems for large main frame computers simply involve blowing a lot of cool air at approximately 12 to 15°C into an underfloor void beneath the room in which the computer is housed. This air emerges through holes which have been cut in the floor beneath each of the computer modules (which are generally about 1m x 1m and 2m high), permeates up through the respective modules and out through grilles at the top of each. Electrical connecting cables of the various modules extend through the same holes in the floor. Additionally, air from the same source is

usually blown directly into the room through slots in the floor so as to provide ventilation for operativesworking in the room.

For numerous reasons these current systems are unsatisfactory. Firstly, the computer modules, some of which are capable of handling 64 million instructions per second and generating 100 horse power of heat, cannot be maintained at a substantially constant temperature by the air coming up through the holes in the floor. This is partly because the modules themselves often have variable rates of heat generation, and partly because there is inadequate air pressure to force the required volume of air up through the respective modules. It is especially important to try and maintain computer modules at an even temperature, otherwise local differences in heat generation (the areas in most frequent use generate most heat) lead to local hot areas and local cold areas which give rise to expansion and contraction and therefore poor or inconsistent electrical connections. In such circumstances the computer inevitably slows down and becomess less efficient and in extreme cases it may shut down altogether.

Secondly, the computer modules cannot be kept clean or within a set humidity range by the known air conditioning systems. This is due to the irregular volume of the air supplied to the modules from beneath the floor and the fact that separate supply of air directly to the room does not favour the drawing of this air through the modules. A major part of each module consists of closely packed vertically arranged printed circuit boards (PCBS), each about ½ sq m in size, carrying a fine meshwork of wiring. Any build-up of dust or area of high or low humidity can cause a bridge to form between wires (in the case of high humidity this occurs due to condensation and in the case of low humidity this occurs due to static) and give rise to short circuiting. This is a very real risk with the present air conditioning systems and attempts should certainly be made to minimise this risk and the above-mentioned risk of expansion and contraction of parts in view of the fact that such computers often cost about £1½ million.

Finally, with known systems to prevent failure of the computer in the event of breakdown of the air conditioning, a complete duplicate system is often provided as a standby and to allow for servicing of the

main system. This is obviously costly and wasteful.

The problem underlying the present invention is the provision of an air conditioning system in which the above-mentioned disadvantages are minimised and which is more economical in size, capital cost and running cost than the present system.

Pursuant hereto, the present invention provides an air conditioning system comprising at least two operative air supply units each in the form of a housing enclosing impeller means operative to draw air into the housing can cause same to flow through filter means and cooling means whereby it is rendered substantially free of contaminants and cooled, and out of the housing via one or more ducts extending beneath floor level to equipment, such as a computer, characterised in that the air supply units are arranged side by side with adjustable dampers provided therebetween so that in the event of failure of one unit, the dampers at one or both sides of that unit may be automatically opened to allow air from other units to supply the equipment connected to that unit until such time as it is repaired, and in that temperature sensors are provided to control the speed of operation of the respective impeller means and/or the temperature of the respective cooling means.

Thus the equipment is maintained within a favourable narrow temperature range and the airflow therethrough is always adequate.

By virtue of damper opening in combination with an increase in the speed of operation of the appropriate impeller means which remain functional, a short-term back-up system is provided. This is, of course, very important when the equipment being air conditioned is a computer which has to be operational and should therefore be air conditioned 24 hours per day.

Preferably each housing includes a plenum chamber beneath floor level and air flows therefrom into the ducts by way of an orifice plate, that is to say a plate having openings of variable area. The area of the openings will be set when each unit is installed depending on the required volume of air flow to deal with expected heat emissions from the relevant equipment. However, the setting of the opening area may be altered from time to time whenever it is deemed necessary.

The dampers are preferably located between the plenum chambers of adjacent units.

Air flow sensors may be disposed in each plenum chamber and/or adjacent air outlets of the equipment being supplied with clean air in order to react to failure of the equipment by actuating the damper opening mechanism and increasing the speed of operation of the impeller means. However, the above-mentioned temperature sensors or other temperature sensors may also carry out this function.

The invention will be described further, by way of example, with reference to the accompanying drawing, in which:-

Fig. 1 is a diagrammatic front view of a row of three slightly different air supply units of an air conditioning system in accordance with the present invention; and

Fig. 2 is a diagrammatic side view of one unit similar to those shown in Fig. 1.

The air conditioning system of the invention comprises a number of air supply units and Fig. 1 illustrates, by way of example, three such units 10, 11, 12. Each consists of a housing 13 enclosing variable speed impeller means in the form of a variable speed fan 14, filter means 15, and cooling

means 16. Filter means 15 of different types are shown diagrammatically in Fig. 1. Typically air filtration will be to about 5 microns. In each unit 10, 11, 12 the filter means 15 is arranged at the top of the housing 13 between an air inlet and the fan 14. The cooling means 16 is arranged therebeneath and typically comprises a refrigeration unit 17 and an adjacent air passage 18, as shown in Fig. 2. Cooling coils 19 are arranged transversely across the air passage 18.

Each housing 13 extends beneath floor level 20 to form a respective plenum chamber 21 which communicates with air supply ducts (not shown) extending beneath the floor 20 by way of orifice plates 22 which have openings of variable area. An air flow sensor and an air temperature sensor are located in the plenum chamber 21 of each housing 13. The units are positioned adjacent each other as shown in Fig. 1, and there is an adjustable damper 23 between the adjacent plenum chambers 21.

The proposed air conditioning system is particularly designed for air conditioning computers and computer rooms and its operation will be described in relation to this special function.

In use a number of units 10, 11, 12 will be installed side by side, e.g. adjacent one wall in a computer room. Each unit may, for example, supply conditioned air to three computer modules. The orifice plates 22 of each unit 10, 11, 12 will be set for an appropriate air volume to be supplied from each, typically 4,000 to 6,000 cu ft/min. When the respective fans 14 are switched on, air is drawn into each housing 13 and passes downwards through the filter means 15 and the cooling means 16 to the respective plenum chambers 22. The temperature sensors in the respective plenum chambers maintain the air supply from the respective units at a constant temperature of e.g. 12°C.

The conditioned air is supplied to the base of the respective computer modules by the underfloor ducts and it flows up through the PCBs substantially equalising the temperature thereof and also sweeping away any excess moisture and dust.

The proposed air supply units should each have a capacity about 30% higher than that normally required in order to provide a back-up system in the event of breakdown of one such unit, i.e. to provide non-stop

24 hour air conditioning to the perpetually working computers. In the event of such a failure, the air-flow or temperature sensor for the failed unit will react to operate a mechanism withdrawing the dampers 23 at one or both sides of the respective plenum chamber 21 so that adjacent units can temporarily help out by supplying air to that chamber and hence to the modules usually supplied by the broken down unit. The air flow sensor for the failed unit would also operate to increase the rate of operation of the fans of the adjacent units sufficient to compensate for the lack of air supply via the failed unit.

It will be appreciated that the foregoing description simply outlines the proposed system in general terms and many minor variations are possible such as the positioning of air-flow and air temperature sensors adjacent air outlets of equipment being supplied with air.

It is firmly believed that use of this air conditioning system (which economically provides climatic consistency and cleanliness) with computers will lead to reliability and longevity of computer operation.

CLAIMS:

1. An air conditioning system comprising at least two operative air supply units (10, 11, 12) each in the form of a housing (13) enclosing impeller means (14) operative to draw air into the housing (13) and cause same to flow through filter means (15) and cooling means (16), whereby it is rendered substantially free of contaminants and cooled, and out of the housing (13) via one or more ducts extending beneath floor level (20) to equipment, such as a computer, characterised in that the units (10, 11, 12) are arranged side by side with adjustable dampers (23) provided therebetween so that in the event of failure of one unit, the dampers (23) at one or both sides of that unit may be automatically opened to allow air from other units to supply the equipment connected to that unit until such time as it is repaired, and in that temperature sensors are provided to control the speed of operation of the respective impeller means (14) and/or the temperature of the respective cooling means (16).

2. An air conditioning system as claimed in claim 1 wherein each housing (13) includes a plenum chamber (21) beneath floor level (20) and air flows therefrom into

the duct or ducts by way of a plate (22) having openings of variable area.

3. An air conditioning system as claimed in claim 2 wherein the dampers (23) are located between the plenum chambers (21) of adjacent units (10, 11, 12).

4. An air conditioning system as claimed in claim 1, 2 or 3 wherein each damper withdrawal mechanism is actuated by means of a temperature sensor.

5. An air conditioning system as claimed in claim 1, 2 or 3 wherein each damper withdrawal mechanism is actuated by means of an air flow sensor.

6. An air conditioning system as claimed in claim 5 when dependent on claim 2 or 3, wherein air flow sensors are located in each plenum chamber (21) and/or adjacent air outlets of the equipment being supplied with clean air,

7. An air conditioning system as claimed in claim 4 or 5 wherein the air flow sensors are capable of controlling the speed of operation of the impeller means (14) of the other units.

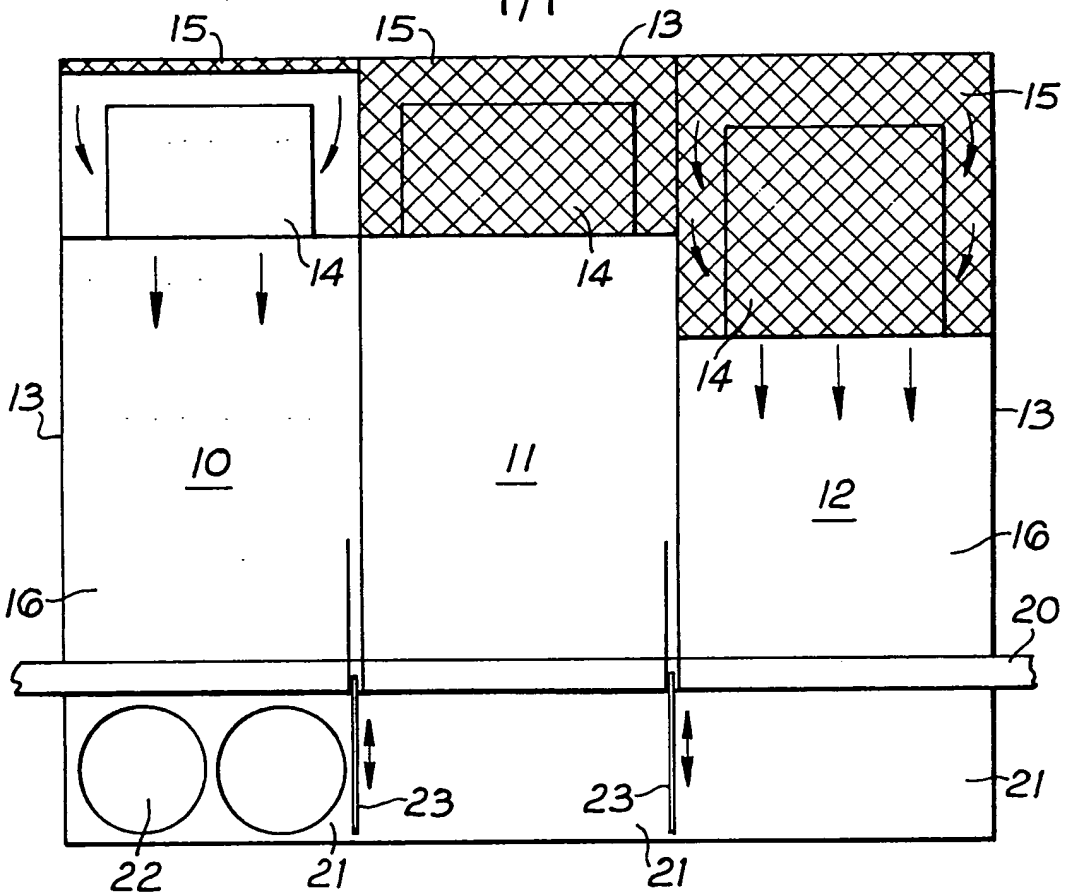

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Fig. 1

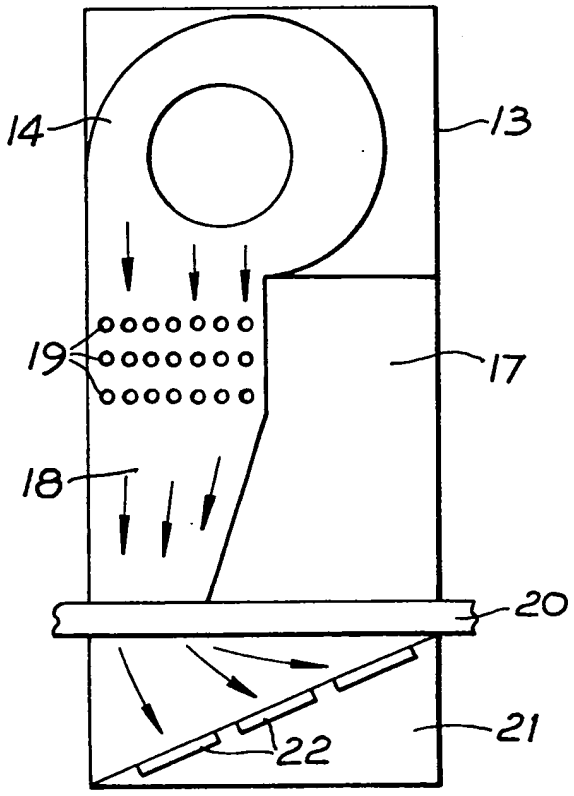
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Fig. 2